

Digital rear-view mirrors in Trucks using overlaid graphics and potentially age effects

Edith Shaocong Rosén, Felicia Törner, Gabriele Pifferi, , Shirin Rafiei, Bo Schenkman, Anders Djupsjöbacka, Börje Andrén, Irene Sperandio and Kjell Brunnström

Enhancing digital rear-view mirrors in Trucks using overlayed graphics

M. Sc thesis: Felicia Törner, Edith Shaodong Rosen



Rosén, E. S., & Törner, F. (2025). *Perceiving the rear view : Design to enhance the human-machine interaction in Camera Monitoring Systems..* Retrieved from <http://urn.kb.se/resolve?urn=urn:nbn:se:ltu:diva-114116> DiVA database

SCREEN II: Overview

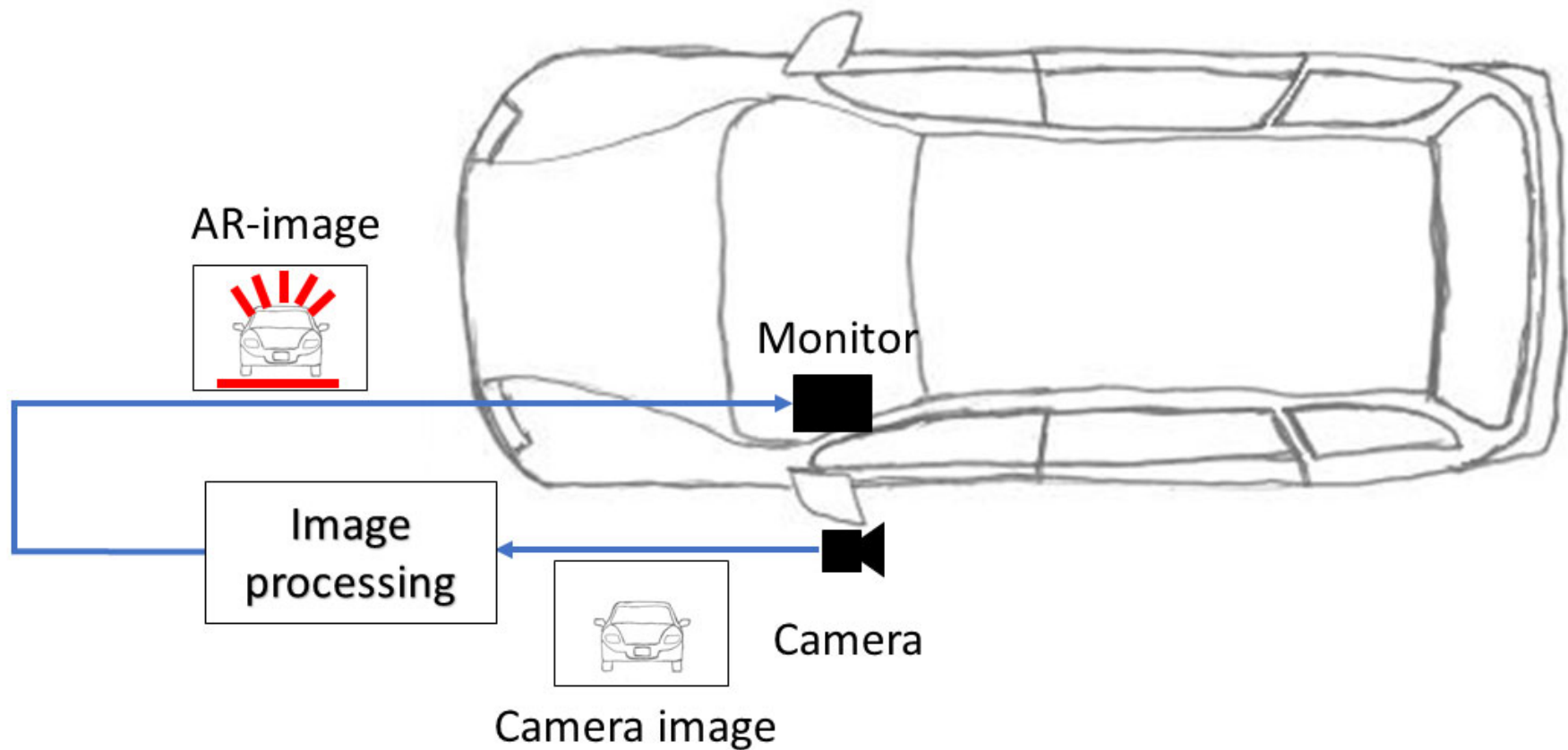


- Safe ChauffeuRs in safe and hEalthy multimodal drivEr information eNvironmentS (SCREENS II)
- Successor of SCREENS which finished March 2023 (RISE and Volvo Cars)
- Overall goal: To develop methods, tools and guidelines as well as knowledge and understanding in creating road-safe and healthy digital information environments for the drivers.
- Three-year project, from 1 Sept. 2023 to 31 Aug. 2026
- Coordinator: RISE
- Partners: Volvo Cars, Volvo Trucks, Scania and Smart Eye

SCREEN II: Motivation



Camera Monitor Systems or Digital rear-view mirrors



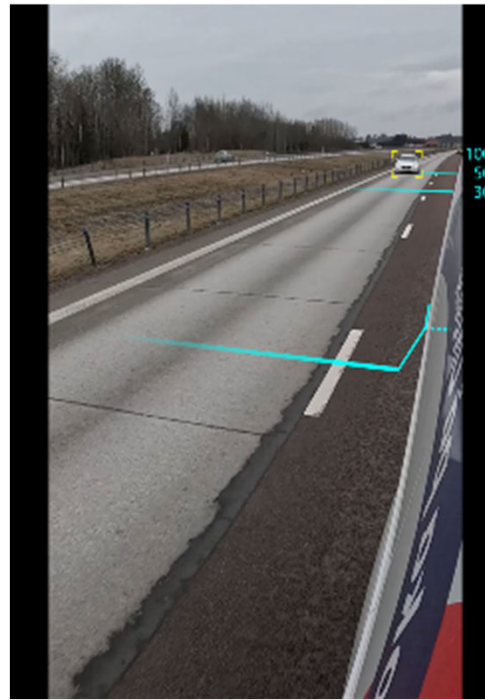
Introduction

- CMS are monoscopic
- 3D perception is reduced, and distance judgement is harder
- Can we improve this with added graphics or augmented information?
- Three different AR overlays were developed
- Overlay graphics may cover at most 2.5% of the CMS field of view

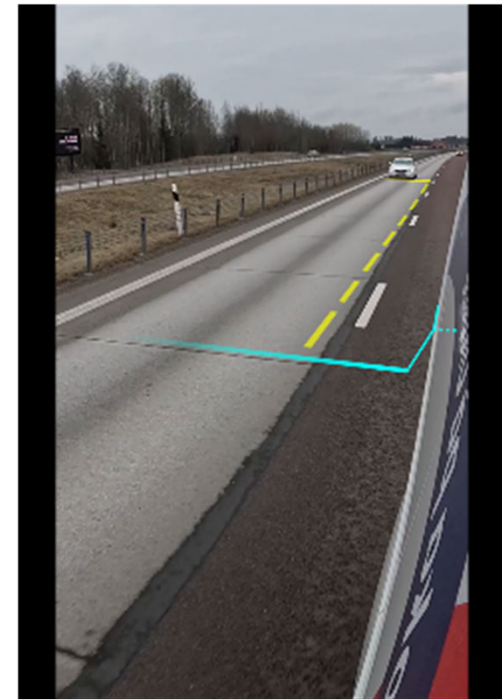
User study on CMS for trucks



Corner



Lines



Dashed

User study on CMS for trucks

- Task distance judgement
- Three concepts + baseline
- Test person were driving along a highway at a beep they should estimate the distance to an oncoming car from behind
- They also rated their certainty of their estimation

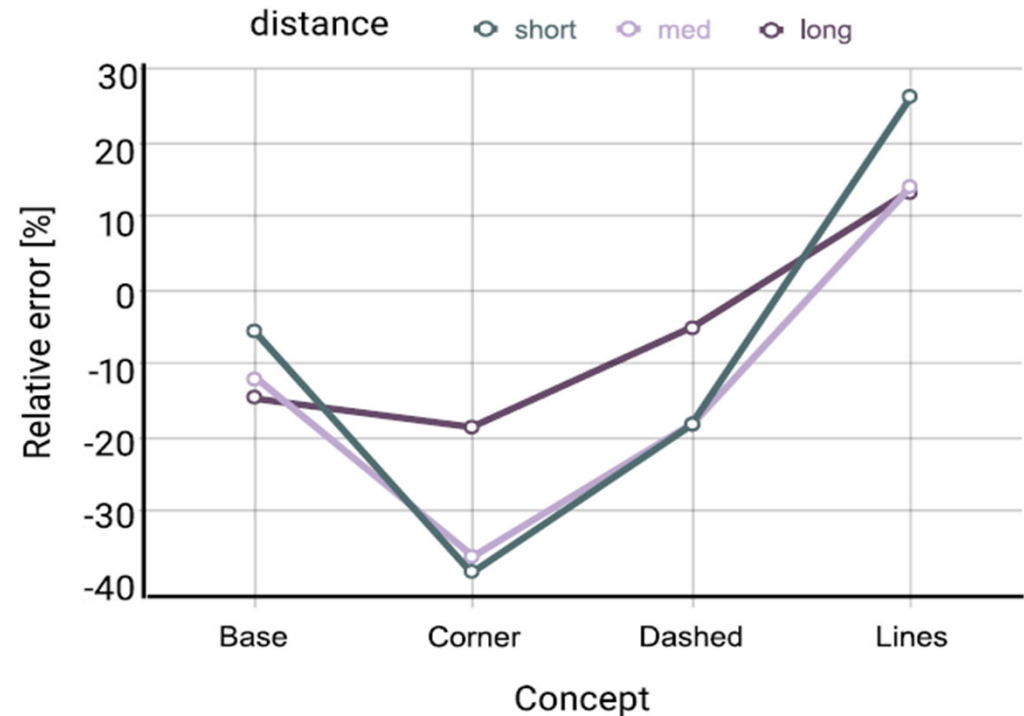


User study on CMS for trucks

- 3 different road scenes, 3 concepts + 1 baseline and 3 distances = 36 conditions
- Distances: 6, 25, 80 meters
- Different randomized playlists were used
- Video presented on 65 inch 4K TV
- 30 participants (18 males and 12 females) (mean age 34)
- All had at least driving license for passenger cars (8 month – 41 years)
- Four had license for trucks

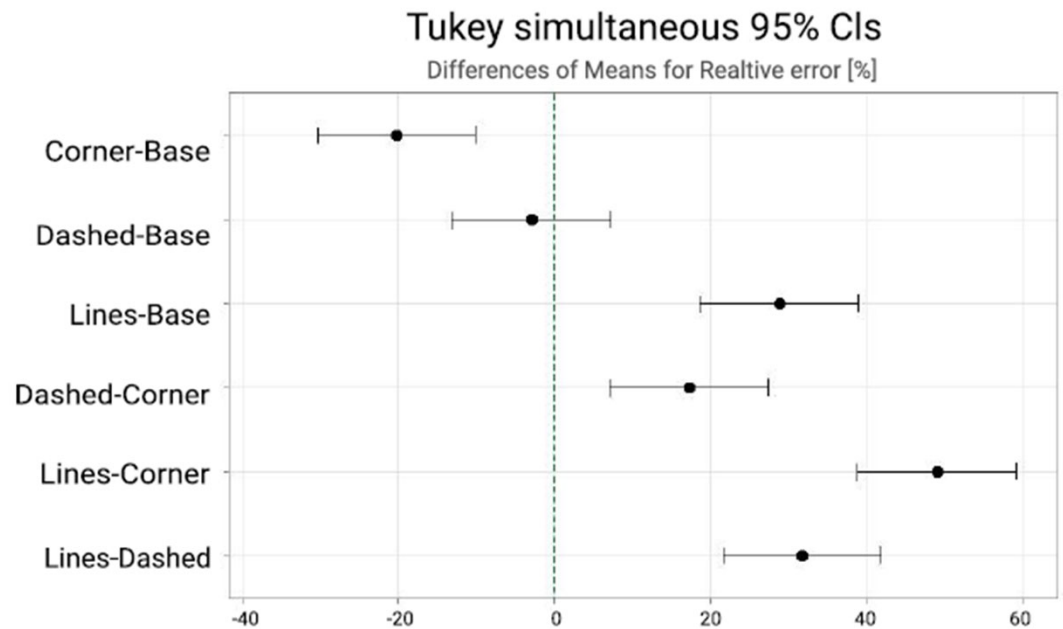
Analysis and Results

- Repeated measures ANOVA and Tukey HSD
- Relative distance was calculated ($\frac{\text{guessed} - \text{actual}}{\text{actual}} * 100$)



Analysis and Results

- Repeated measures ANOVA and Tukey HSD
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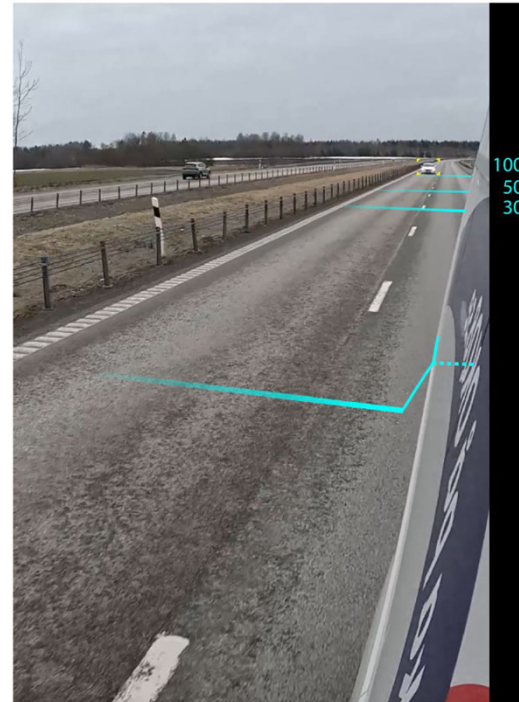
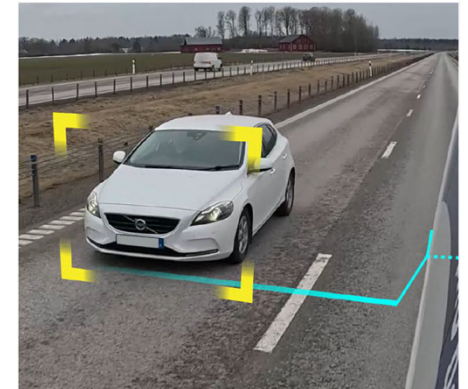


Analysis and Results

- Lines concept performed most overestimating and corners most underestimating
- Lines was rated most helpful and desirable in questionnaire
- Lines and corners were taken as candidates for further development of overlay-based driver assistance in trucks

Improved design

- Corner element thickened
- Fading of the lines improved
- Overlayes adjusted to move smoother with the overtaking car



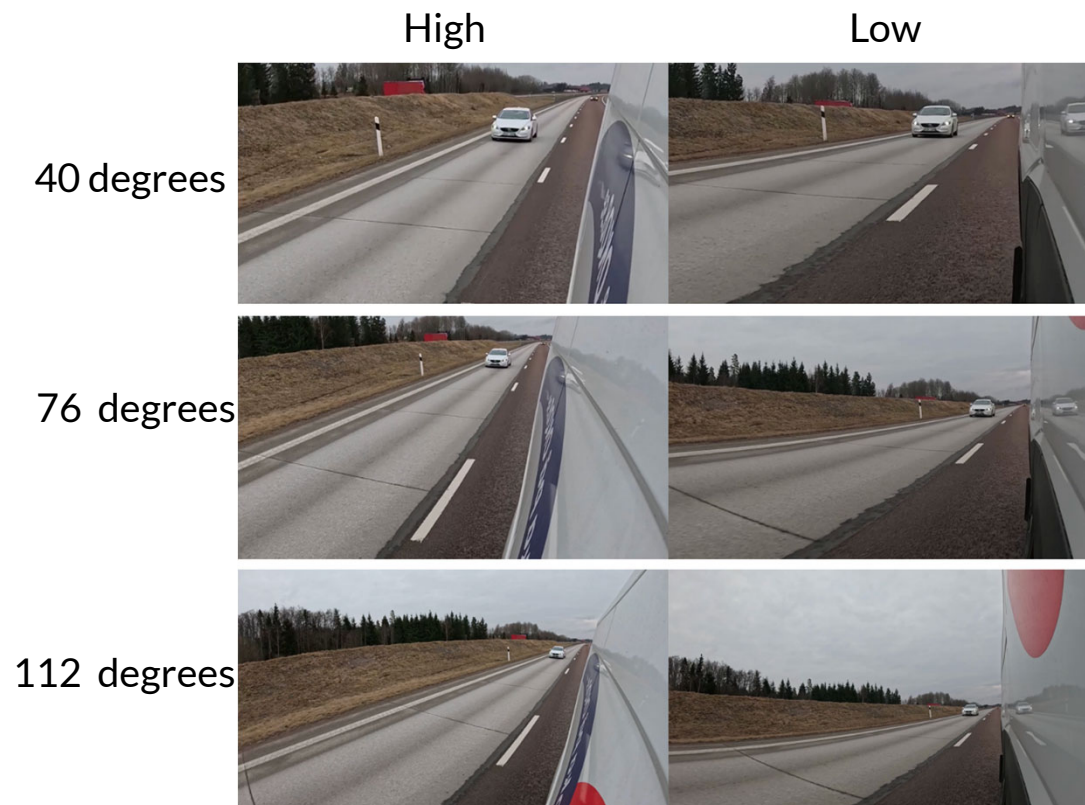
The influence of driver-age on judging the distance of approaching vehicles in digital rear-view mirrors.

M. Sc thesis: Gabriele Pifferi (not published yet)

Thulinsson, F., & Söderlund, N. (2024). *Mirror, Mirror on the Car : An Explorative Study on how CMS Perspective Impact Driver Depth Perception and Decision Making*. (Independent thesis Advanced level (professional degree) Student thesisThesis). Retrieved from <http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-532768> DiVA database. (24039)

Thulinsson, F., Söderlund, N., Rafiei, S., Schenkman, B., Djupsjöbacka, A., Andrén, B., & Brunnström, K. (2025). *Impact of Camera Height and Field-of-View on Distance Judgement and Gap Selection in Digital Rear-view Mirrors in Vehicles*. In *Electronic Imaging*. doi:<https://doi.org/10.2352/EI.2025.37.11.HVEI-199>

User study on CMS

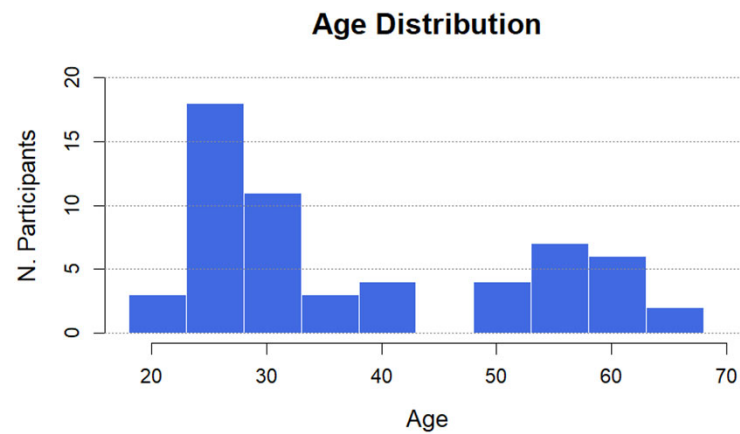
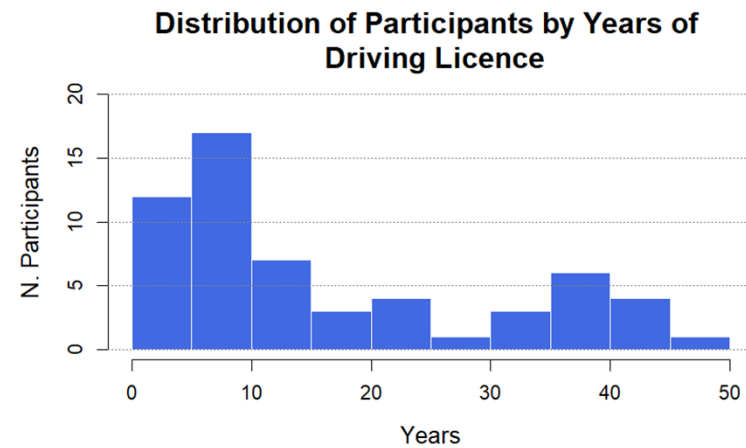


User study on CMS

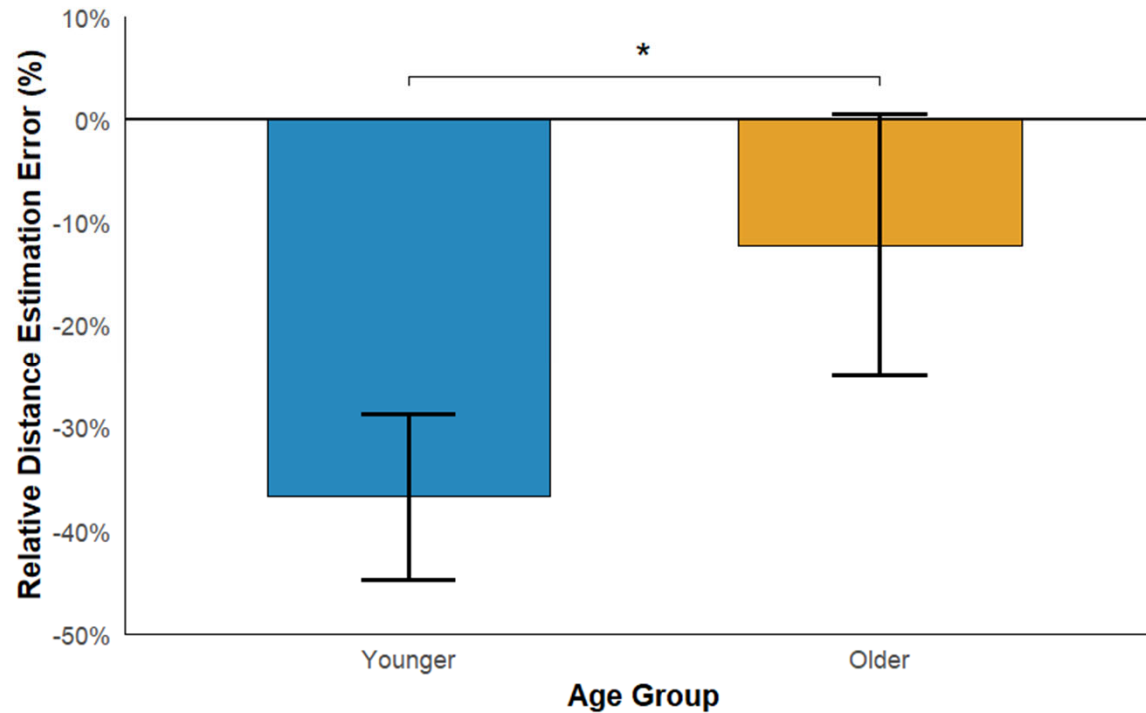


Results

- The total number of participants was 58 (age range = 22-64; SD = 14)



CMS: Distance estimation by age

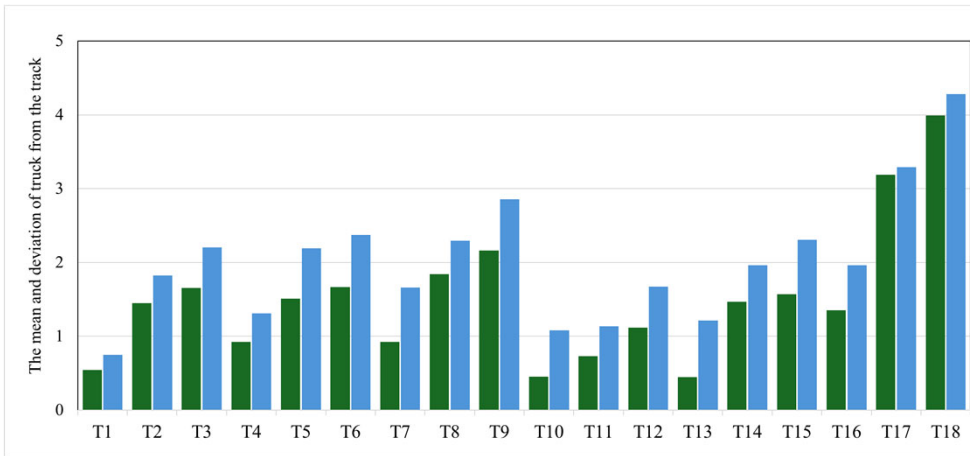
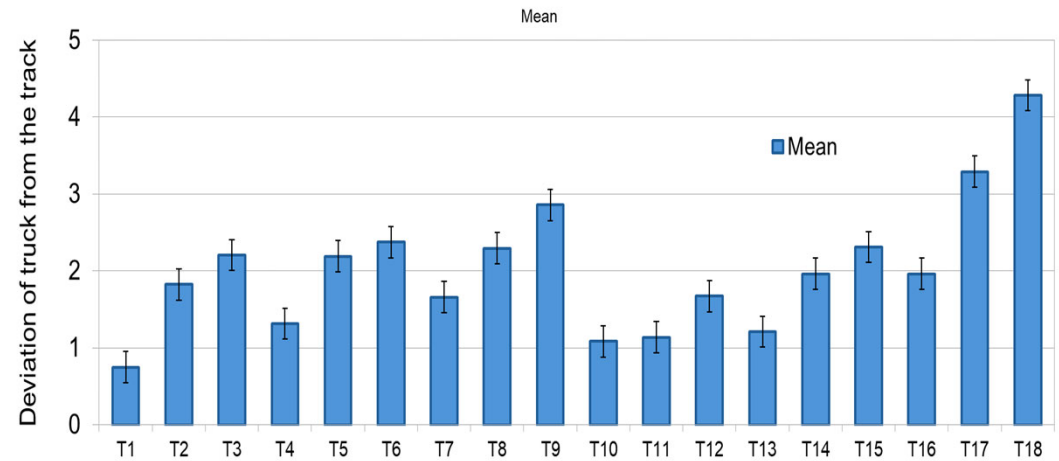


Conclusions

- Added graphics can be helpful for the distance judgement
- Older (more experienced) drivers are better at distance judgement than younger drivers.

Thank you!

Kjell Brunnström kjell.brunnstrom@ri.se



Modeling human behavior using a mixed methodology involves combining both quantitative and qualitative research approaches to understand how people perform and feel while interacting with a system. In the context of a Remote Control System, this means examining not just objective performance metrics (like task completion time, accuracy, error rates), but also subjective experiences (like satisfaction, comfort, frustration) during the interaction.

Key Concepts in This Mixed Methodology:

- Quantitative Analysis (Performance):** Performance metrics are collected through quantitative data (e.g., task completion time, number of errors, efficiency). These metrics help measure how effectively users are performing a task using the system. For example, in a Remote Control System, you might measure how long it takes a user to complete a remote navigation task or how accurately they can maneuver an object.
- Qualitative Analysis (Satisfaction):** Qualitative methods focus on users' subjective experiences—their satisfaction, ease of use, emotional responses, and comfort levels. This can be gathered through surveys, interviews, or focus groups. For instance, after interacting with the Remote Control System, users may be asked about their satisfaction with the interface or how intuitive they found the controls. Their comments can reveal insights into user frustration or enjoyment that quantitative metrics may miss.

Why Mixed Methods?: A mixed-methods approach is essential because it provides a more holistic view of the user experience. Quantitative performance metrics alone cannot capture whether users felt comfortable or frustrated, and qualitative feedback alone doesn't show how efficient or accurate users were. This approach helps in designing systems that not only perform well technically but also provide a positive user experience.

Example in a Remote

Control System: In a Remote Control System context, mixed-method modeling would involve:

- Quantitative data:** Tracking how fast users can perform remote tasks (like operating a drone or robot), and measuring error rates or task completion success.
- Qualitative data:** Collecting feedback about their satisfaction with the video quality, ease of controlling the system, and overall experience with latency or depth perception issues.

By combining both, the model can identify correlations between performance and user satisfaction. For instance, if users perform a task faster but report lower satisfaction due to poor video quality or high latency, it reveals a gap between the system's efficiency and user experience.

Benefits:

- Improved design:** This method helps designers understand where the system excels technically but falls short in user experience, allowing for balanced improvements.
- More informed decision-making:** Mixed methods provide richer data for stakeholders, helping them make better decisions about system upgrades or adjustments.

Conclusion: Modeling human behavior using a mixed methodology enables researchers and designers to balance performance metrics with user satisfaction, leading to systems that are both technically efficient and enjoyable to use. It's a comprehensive way to evaluate user interaction with systems like Remote Control Systems, which require not just good performance but also positive user experiences for successful adoption.

Marc Hassenzahl uses the metaphor "User Experience (UX) is not just 'old wine in new bottles'" to explain that UX is a **distinct** and **extended perspective** on the quality of interactive technology, moving beyond traditional views focused solely on functionality. Instead, it emphasizes the **experiential** and **emotional aspects** of interaction, highlighting how products fulfill deeper human needs beyond basic usability .

This metaphor suggests that **UX design** brings a fresh, deeper layer of understanding to technology, where the focus is not just on the product's utility but on how it contributes to meaningful, positive experiences for users.

Typsnitt

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- Lato Regular/Bold
- Roboto Mono Regular/Bold.

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Sidfot

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Infoga > Sidhuvud och Sidfot

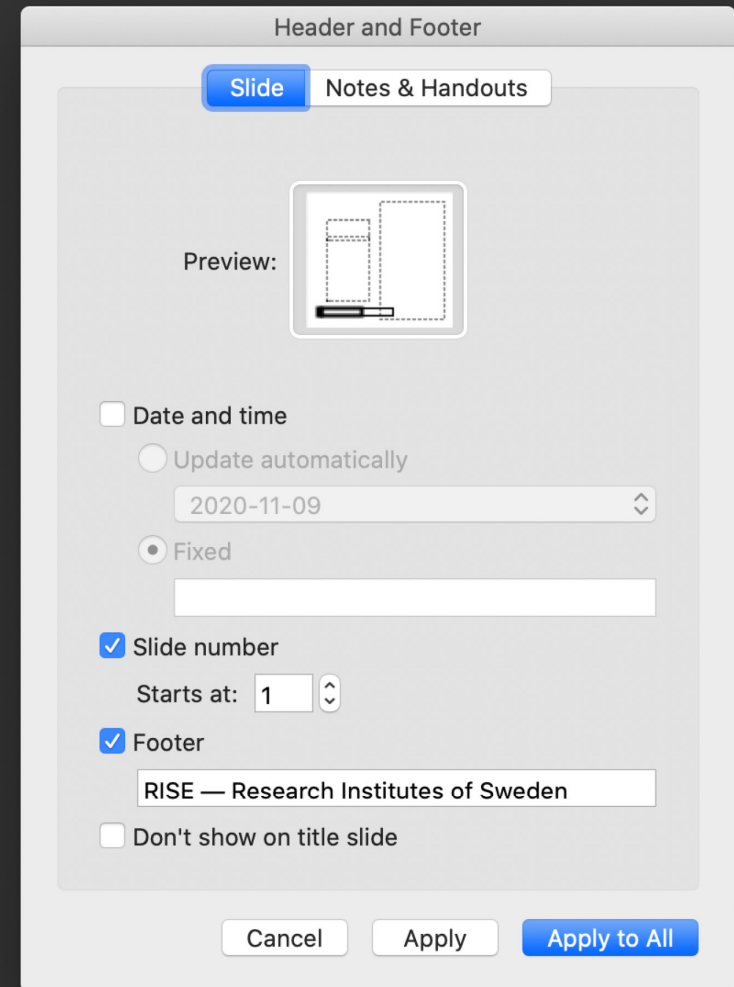
Klicka i Sidfot och skriv in din titel.

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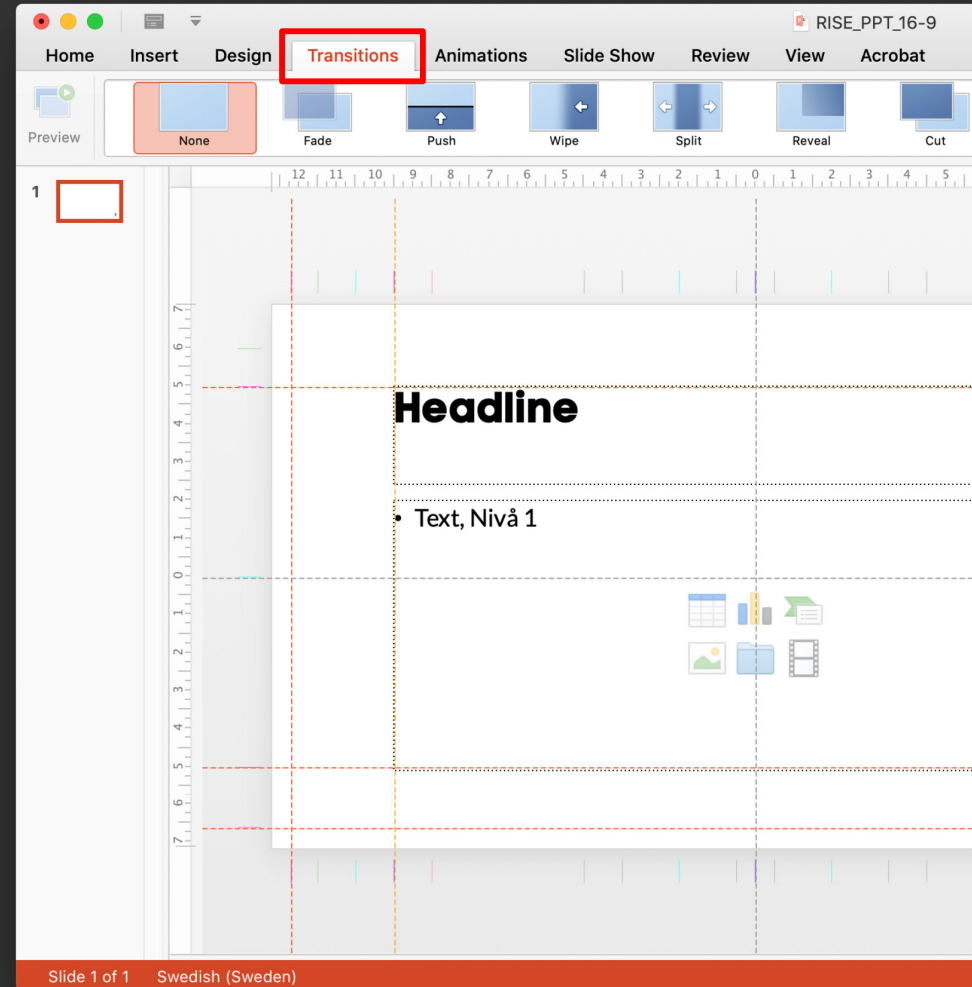


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Byta språk

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Mac: Go to **Tools > Language**. Set preferred language and select **Set As Default**.

SCREEN II

WP5:

20092023

Standard agenda for WP5

- Passenger cars
- Volvo Cars
 - Considerations:
 - Different technologies and cross platform work needs to be handled.
 - Suggestion to focus on studies instead of strictly on WPs.

Action points

What	Creation date	Responsible	Deadline	Status

Potential Demo

- How many demos do we have
 - **Optea HUD – Esteban (will present)**
 - CMS in Trucks not allowed to do – Nina (will not present)
 - **There is a possibility to show a competitor truck system – Nina (will present)**
 - Potential for demo of Simulator – VR (Nina) – David believe actual system has more value
 - **Volvo Cars AR HUD - (CMS due to technical issues is not possible) – David**
 - **Desktop Demo – SmartEye - Svitlana Finér**
 - **RISE – Eye motion data collection platform (you could plug in any data streaming) – Jonas**

Suggestion: having Vinnova to show the project is funding.

Two columns of text

- Natus excestemolor audi si cum es et
 - Quibea incture henimus simil elecus voluptatem
 - Fugit ex endus, que est et
 - Officimus corem velest, tem que volupissum
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 - Quibea incture henimus simil elecus voluptatem fugit ex endus, que est et
 - Officimus corem velest, tem que volupissum

Research at RISE Visual Media Quality: Camera Monitor System (CMS) and Augmented Telepresence in Trucks and Remote Control systems

Kjell Brunnström, Shirin Rafiei

Grön

MÖNSTER

- Kopiera mönstret.
- Klistra in på vald slide.
- Beskär mönstret genom att högerklicka och välja **Beskär**.

PATTERNS

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Rosa

Vit

Gul

Grön

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Rosa

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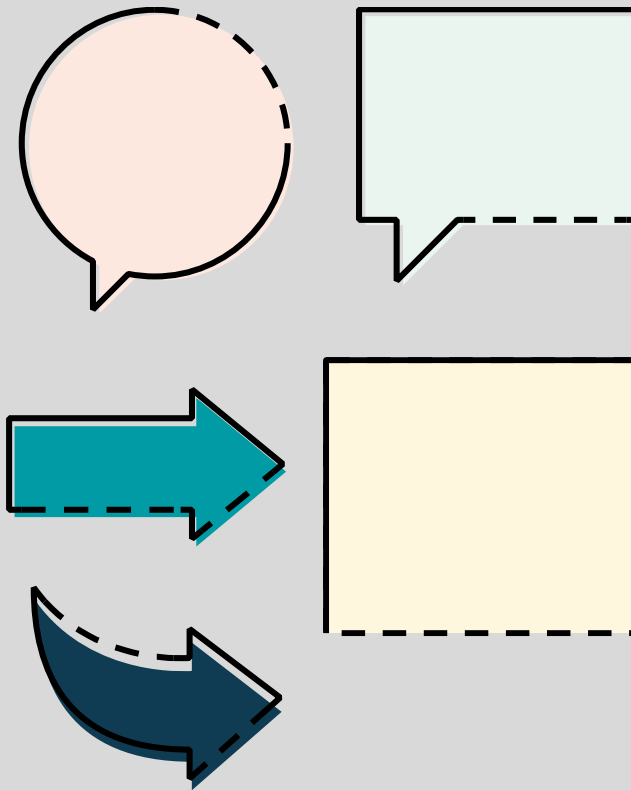
Gul

INFOGRAFIK

- Här är ett par exempel på infografik.
- Mer grafik hittar du på Kommunikationslabbet.

INFO GRAPHICS

- These are some examples of info graphics and our logo.
- More illustrations can be found on Kommunikationslabbet.



LOGOTYP

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LOGO

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